Lessons Learned From Evaluation of the interactIVe Project and next steps towards the evaluation of automated driving

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interactIVe – Overview Project

The interactIVe vision:
Accident-free traffic and active safety systems in all vehicles

- Facts:
  - Duration: 48 months (January 2010 – November 2013)
  - 29 partners of 10 countries
  - Budget: 30 Million € (European Commission funding: 17 Million €)

- Objectives:
  - Create an innovative model and platform perception
  - Extend range of possible scenarios and usability of ADAS by multiple integrated functions and active interventions
  - Improve decision strategies for active safety
  - Develop solutions for collision mitigation for lower-class vehicle segments
  - Further encourage the application of standard methodologies for the evaluation of ADAS
interactIVe - Overview Functions

**Driver Support**
- Continuous Support
- Curve Speed Control
- Enhanced Dynamic Pass Predictor
- Safe Cruise

**Collision Avoidance**
- Lane Change Collis. Avoid.
- Oncoming Vehicle Collis. Avoidance/Mitigation
- Rear End Collis. Avoidance
- Side Impact Avoidance
- Run-off Road Prevention

**Collision Mitigation**
- Emergency Steer Assist
- Collision Mitigation
Role in interactIVe:
- Definition of a test and evaluation framework
- Development of test scenarios, procedures and evaluation methods
- Provision of tools (e.g. equipment, test catalogues, questionnaires or software) and test support
- Definition of test and evaluation criteria

Evaluation divided into:
- Technical assessment (on function level)
- User-related assessment
- Impact assessment
- Legal aspects

Diagram:
- Definition of Research questions (D7.1)
- Definition of Hypotheses (D7.2)
- Definition of Indicators (D7.2)
- Test and Evaluation Plan (D7.4)
- Evaluation of Function (D7.5)
- Verification of Hypotheses
- Calculation of Indicators
- Measurement Data
- Test of Function

interactIVe - SP “Evaluation and legal aspects”
Facts

- Tested **conflict types**:
  - Rear-end, Head-on, Blind spot, Road Departure, Crossing Traffic, VRU, Excessive Speed, Traffic Rule Violation

- In total over 900 test runs
- 30 general hypotheses (for all functions)
- 63 specific hypotheses
User-related Assessment – Evaluation and Test Design

- 9 studies with 263 test persons have been conducted
- Method chosen depending on the criticality of the system under investigation
  - Small field test
  - Focus group studies
  - Test on a test track
  - Driving simulator studies

Source: VTEC

Source: Ford

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Safety Impact Assessment – Methodology

• Approach for safety impact assessment
  • Safety Mechanisms (direct effects by means of accident re-simulation)

- function description
- target scenarios
- technical assessment
- user-related assessment
- GIDAS accident database
- reconsider accident with effects of new function
- scale up using CARE/national databases
- Deployment scenario; penetration rate

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Result of interactIVe I

- Technical Assessment
  - The interactIVe functions behaved as intended and showed overall positive results
  - Differences in the maturity of the functions were observed during the analysis of the false activation behavior

- User-related Assessment
  - In general it can be concluded that the test persons found all assessed interactIVe functions useful
  - The mean values of the test persons’ willingness to pay are higher than 500 € for most of the functions
  - Tested persons are willing to pay more for functions that intervene
### Result of interactIVe II

**Safety Impact Assessment**

- 364 in-depth accident cases analysed
- Relevant for 4 functions
- Varying results: 21% - 77% rear ends *potentially* avoided, others mitigated
- This holds for selection of GIDAS scenarios

#### System Intervention vs. Driver Reaction

<table>
<thead>
<tr>
<th>System/Driver</th>
<th>Collision Avoided</th>
<th>Collision Mitigated</th>
<th>No Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Driver+System intervention</td>
<td>71%</td>
<td>30%</td>
<td>22%</td>
</tr>
<tr>
<td>Driver+System intervention</td>
<td>77%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>System intervention only</td>
<td>21%</td>
<td>77%</td>
<td>2%</td>
</tr>
<tr>
<td>Driver reaction only</td>
<td>65%</td>
<td>27%</td>
<td>8%</td>
</tr>
<tr>
<td>Driver reaction only</td>
<td>70%</td>
<td>21%</td>
<td>8%</td>
</tr>
<tr>
<td>System intervention only</td>
<td>24%</td>
<td>34%</td>
<td>42%</td>
</tr>
</tbody>
</table>

- Outside speed operational conditions
- No effect
- Collision mitigated
- Collision avoided

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Lessons Learned I

• General:
  • The evaluation was affected by delays in the function development. This required a close cooperation between the responsible partners.
  • Trade-off between tests amount and information required for the evaluation.

• Technical Assessment
  • Results are hardly comparable and cannot be harmonized, if boundary conditions are not in the same range and show high variations.
  • Rear-end scenarios are quite well described and test tools are sufficiently available, e.g. Euro NCAP.
  • The lateral conflict test cases (blind-spot and run-off road) are difficult to perform and hardly standardized. Oncoming and crossing conflict scenarios a standardization and appropriated test tools is missing.
Lessons Learned II

• User-related assessment:
  • The assessment was mainly affected by the restrictions on the permission to drive the test vehicles. In many cases naïve test persons were not allowed to drive the test vehicles.

• Impact Assessment
  • The main issue for the safety impact assessment is the availability of adequate accident data, that allow a detailed reconstruction respectively re-simulation of the accident (lateral conflicts).

• Open Issues:
  • Investigation of long term effects for the user interaction.
  • Bundles of functions in demonstrator → interference effect in case two functions addressing the same use case (e.g. a warning and an intervening function).
  • Finally, additional research on the evaluation methodology is necessary, if the function affects not only certain scenarios but also the whole traffic as it is the case for automated driving functions.
Evaluation of automated driving - AdaptiVe

- **Duration:** January 1, 2014 - June 30, 2017
- **Coordinator:** Volkswagen Group Research
- **Consortium:** 29 partners from 8 countries - France, Germany, Greece, Italy, Spain, Sweden, The Netherlands, United Kingdom; including 11 OEMs, 4 suppliers, 11 research institutes and universities, and 3 SMEs
- **Research Budget:** EUR 25 million

- **SP Evaluation**
  - **Assessments:** Technical, User-related, In-traffic, Impact
  - **Lead:** ika
  - **Partners:** BAST, BMW, CTAG, CRF, Lund University, TNO
Classification of automated driving functions:

• **Event based operating**
  – Function that is only active for a short period in time (typically vehicle stands still at the end or the automated driving ends)
  – Examples: Parking, Minimum Risk Manoeuvres

• **Continuously operating**
  – Function that is active for a longer period in time (typically vehicle is still moving at the end of an manoeuvre respectively automated driving is continued)
  – Example: Highway Pilot
// Summary

- interactlVe project developed ADAS related to active safety

- Technical, user-related and safety impact assessment has been conducted for the interactlVe function

- Results of the assessments as well as the lessons learned have been presented

- Next step is evaluation of automated driving function, on which it will be concentrated in the project AdaptlVe
Thank you.

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